Guest Editorial

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Transcutaneous fetal Pco_2 monitoring during labor — an introduction to the EEC multicenter trial

Until the last few years fetal heart rate monitoring has been the routine method for evaluating fetal well-being during labor. Although cardiotocography makes the heart rate counting very exact, it still is difficult to correlate CTG-patterns to fetal depression.

Since it was introduced 25 years ago, the use of fetal blood sampling and analysis (FBA) [4] helped in the interpretation of CTG patterns. Usually the pH has been used as indicator for acidosis. However, animal studies have demonstrated that hypoxic metabolic acidosis is far more dangerous in the development of brain damage [1]. Consequently, distinguishing respiratory from metabolic acidosis is also important. The separation between respiratory and metabolic acidosis is easily done by fetal blood analysis, when pH and Pco_2 is measured, and the Standard Base Excess (SBE) is calculated. The disadvantages of fetal blood sampling is the discontinuity and the invasive character of the procedure. Further, many parturients object against the incision of the fetal skin.

Transcutaneous carbon dioxide monitoring is non-invasive and continuous, but before using this method for fetal monitoring it is necessary to evaluate whether the method can detect both respiratory and metabolic acidosis. A respiratory acidosis will always be detected if the electrode measures correctly as the carbon dioxide tension by definition is elevated. A metabolic acidosis caused by hypoxia is characterized by a low negative SBE because of lactic acid produced by anaerobic metabolism. The low oxygen tension is usually caused by a decreased oxygen exchange in the placenta and the carbon dioxide exchange will presumably also be decreased, and therefore increasing Pco_2 must be expected. This indicates that during the first period of the development of metabolic acidosis there will be some degree of respiratory acidosis, too [5]. Further, the low oxygen tension causes anaerobic metabolism which produces lactic acid. The lactid acid will change the equillibrium between bicarbonate and carbon dioxide towards carbon dioxide formation. A combination of this CO_2 production and the decreased CO_2 exchange in the placenta will result in an increased fetal Pco_2. Consequently, a metabolic acidosis can be detected by monitoring the carbon dioxide tension — at least theoretically.

To evaluate the correlation between pH and Pco_2 we studied these parameters in umbilical artery blood measured immediately after delivery in 300 cases [3]. In all cases with low pH (including all 22 cases with SBE below -10 mmol/l) we found elevated Pco_2 values.

Fetal Pco_2 tension has been measured by fetal blood sampling during the last 20 years. Normal range of carbon dioxide tension was evaluated in different studies [2]. Increasing values during labor was found in most of the studies, but as only a few blood samples were taken from each fetus the actual change during labor is difficult to evaluate. In some of these studies the carbon dioxide tension was measured during pathological deliveries and elevated Pco_2-values were found especially during the second stage of labor when bradycardia and meconium stained liquor was present.

In this issue of the Journal of Perinatal Medicine 4 European centers present their results concerning $tcPco_2$ in obstetrical monitoring.

The method is still very new and the present stage can be characterized by the fact that normal values are beginning to appear but the few cases of fetal pathology still limit the conclusions concerning intervention limits:

1) at which level of $tcPco_2$ is it justified *not* to intervene in spite of a pathological CTG (e. g. by FBA including all acid-base parameters)? *and*
2) when does the $tcPco_2$ alone indicate intervention (e. g. FBA or cesarean section)?

If corrected to a temperature of 37 °C the mean normal values of the three most experienced groups were as follows (values of the Copenhagen group will be published later):

During the 1st stage of labor:

5.3 kPa (40 mm Hg) (Berlin 44 °C),
6.1 kPa (46 mm Hg) (Berlin 39 °C),
6.3 kPa (47 mm Hg) (Toulouse 41 °C),
5.9 – 6.3 kPa (44 – 47 mm Hg) at 3 – 9 cm dilatation (Copenhagen 44 °C),
6.1 – 7.2 kPa (46 – 54 mm Hg) at 3 – 9 cm dilatation (Copenhagen 41 °C).

During the 2nd stage of labor:

6.4 kPa (48 mm Hg) (Berlin 44 °C),
7.2 kPa (54 mm Hg) (Berlin 39 °C),
6.3 kPa (47 mm Hg) (Toulouse 41 °C),
6.4 – 7.2 kPa (48 – 54 mm Hg) from the beginning to the end of the 2nd stage (Copenhagen 44 °C),
7.3 – 7.9 kPa (55 – 59 mm Hg) from the beginning to the end of the 2nd stage (Copenhagen 41 °C).

Consequently, the normal values does not differ very much, and small variations of normal values of $tcPco_2$ are understandable, as management of labor (e. g. the degree of hyperventilation, oxygen administration, drugs) is different among the centers. It is mandatory to define normal ranges at each department before using $tcPco_2$ for clinical decisions.

In the same issue the two fixation methods are presented. It seems that the stabilization time is shorter when the suction method is used, probably because the head is not cleaned before application (the moisture of the fetal skin is a good conductor of CO_2). Another reason for the faster stabilization time by suction fixation might be a more pronounced hyperaemia caused by the negative pressure itself. Further, reapplication of suction fixated electrodes is easier allowing monitoring for longer periods, especially during the 2nd stage.

Consequently, at present we recommend suction fixation of the $tcPco_2$ electrode for obstetric monitoring.

At present within the frame of the European Community Project "Perinatal Monitoring" a Danish, German, Dutch, French and two English teams are gathering experience in transcutaneous Pco_2 monitoring of the fetus. Within one year we hope to be able to present a very large material consisting of both normal and acidotic fetuses. When this is accomplished it will be possible to make conclusions on the applicability of this way of fetal monitoring in clinical practice.

References

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Tom Weber and Carsten Nickelsen
Department of Obstetrics and Gynecology
Rigshospitalet and Hvidovre Hospital
University of Copenhagen
Denmark